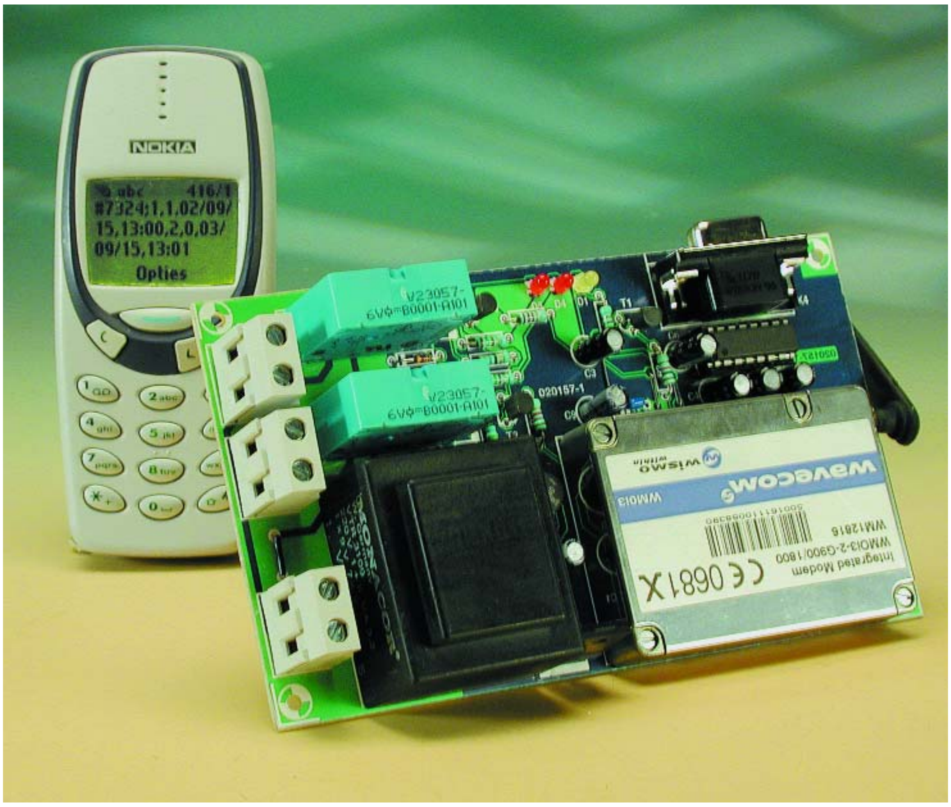
SMS-Controlled Mains Sockets

remote appliance control by GSM phone

Design by A. Elallali (Unitronic)

Using a simple SMS message sent from your GSM phone, two mains powered loads may to be switched on and off independently, or programmed to do so at a specified time.



Remote control by telephone and other telecommunication systems like transmitters/receivers are no new subjects to *Elektor Electronics* readers. Over a decade ago, we already published the design of a switching unit with seven outputs under the control of DTMF signals sent over the telephone network. Related items in the Elektor projects archive include a Personal Mini Web Server (September & October 2001) and the 535 'Lite Board which was capable of initiating control actions using SMS.

As far as functionality is concerned, the project described in this article corresponds to the first project we mentioned — technology-wise it is more in line with the latter project.

Briefly, the project is about an SMS receiver which has been programmed and configured to take control over two mains sockets — in other words, mains powered loads connected to these sockets may be switched on and off independently by sending an appropriate SMS message. Switching on or off may be immediate, but also at a predetermined time, thanks to the use of a programmable real-time clock.

GSM modem

As with the Personal Mini Web Server, a special module is employed for the complete telecommunications function (**Figure 1**). In fact, everything related to SMS reception is 'safely left' to the module. The module involved is manufactured by the French company Wavecom (www.wavecom.com) and may be obtained from their distributors, including Unitronic in Düsseldorf, Germany (www.unitronic.de). The module type WMOi3 is a dual-band GSM Modem for the 900 MHz and 1800 MHz bands. It is fluent in telephony, Voicemail, SMS transmission and reception, fax (Group 3), data transmission and many more, all without the need for additional hardware.

The small steel case, which is a bit smaller than a cigarette case, comprises a SIM card tray, an antenna socket and a 50-way connector covering a wide variety of functions and bus systems: power supply, two microphone preamplifiers, two AF power amplifiers, a fully configured RS232 interface, an A/D converter, a keypad terminal, an SPI and an I^{2}C bus, connectivity for an external SIM card holder, two digital inputs/outputs and a number of control lines.

Of this plethora of functions offered by the 50-way connector, the present project employs just the two digital I/O lines, two control lines (on/off and busy) and the RS232 port which, by the way, is only required in case you lost the password and would like to return the system to its default values.

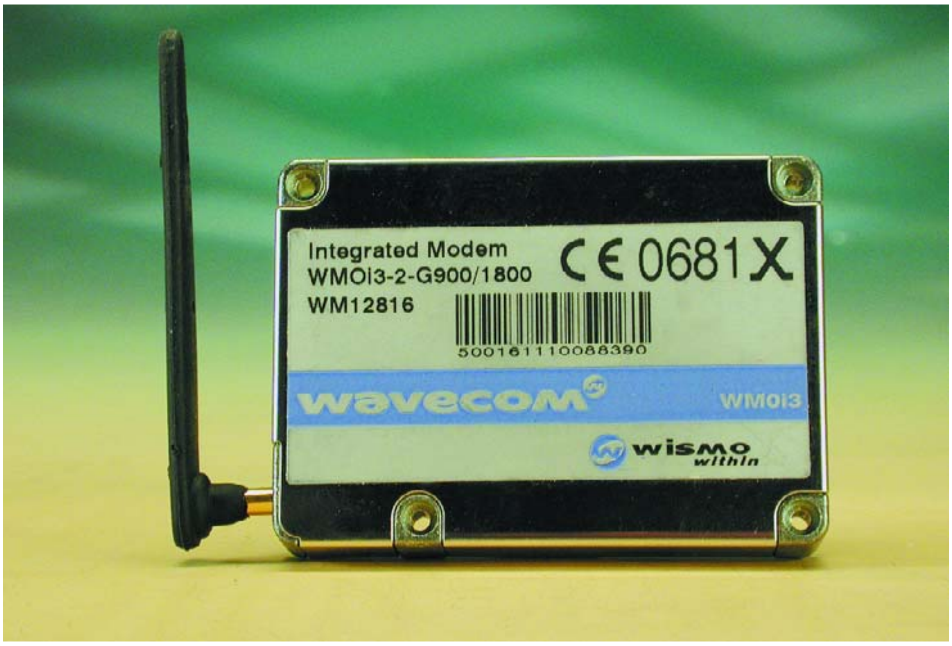


Figure 1. Heart of the project: the ready-programmed GSM modem supplied by Unitronic.

OpenAT

The 'heart' of the SMS-Controlled Mains Sockets unit is certainly not cheap, but definitely worth the investment because it can be programmed in a special programming language called OpenAT. The programmability obviates the need for a microcontroller which is typically expected in such a system.

As you may have surmised from the name of the language, OpenAT finds its roots in the AT command set originally designed by Hayes for telephone modems. An OpenAT application consists of the user-specific, embedded application that was linked to, and developed using, the OpenAT library. The library, in turn, is based on a multitude of different APIs (Application Programming Interfaces) developed by Wavecom:

Application Mandatory API
which has to be used by the embedded application.

AT Command API
which give access to the set of AT functions (Send AT Commands, subscribe to unsolicited/intermediate indications).

OS API
which gives access to the operating system functions (Start/Stop timer, Read/Write data in Flash memory, Init/Get/Release memory, Delete objects stored in Flash memory).

PCM API
which give access to the Flow Control Manager functions, afford sure access to V24 and Data I/O (Open/Close flow, Send/Receive Data).

I/O API
for control over the serial link and the GPIO (here, the two mains sockets).

Bus API
which looks after the SPI and I^{2}C bus systems.

Standard API
with a number of standard C functions.

Figure 2 illustrates the interaction between the APIs and the user application contained in the Wavecom module.

No need to panic at this point — to be able

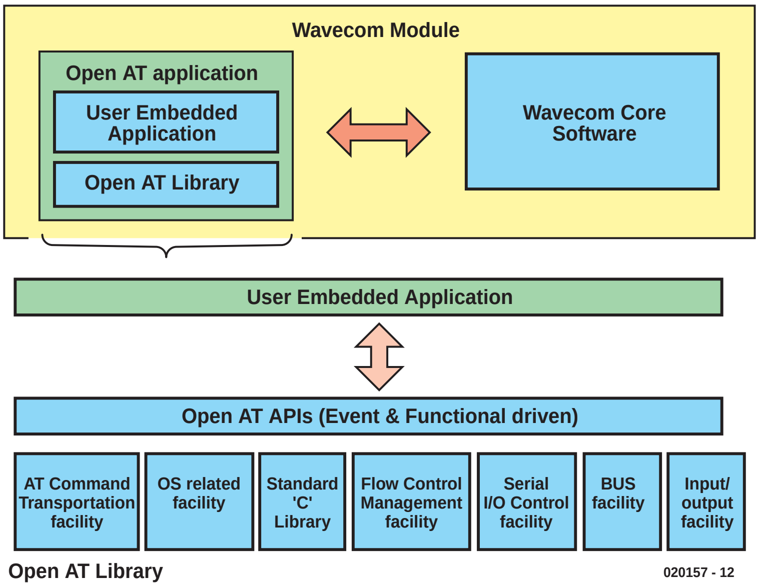

Wavecom Module
Open AT application
User Embedded Application
Open AT Library
Wavecom Core Software
User Embedded Application
Open AT APIs (Event & Functional driven)
AT Command Transportation facility
OS related facility
Standard 'C' Library
Flow Control Management facility
Serial I/O Control facility
BUS facility
Input/ output facility
Open AT Library
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Figure 2. Illustrating the interaction of the APIs with the user application.

to build and use this project no deep knowledge is required of yet another exotic programming language. The crux: all the necessary software is already resident in the GSM modem if you order it from Unitronic. As an exception, the system software can not be offered as a Free Download from the *Elektor Electronics* website, and this may require some explaining. OpenAT (also referred to as the MUSE platform) will set you back about £3,500 and in addition requires an ARM Compiler costing another £2.5 k or so. Such expenditure we reckon belongs in the industrial and high-end professional realms. Obviously, for small volume production and even one-offs, the software development is better commissioned to Unitronic.

Around the modem

As you can see from the circuit diagram (**Figure 3**) the additional electronics consist of little more than a level converter, two buffered relay outputs and a mains power supply. The Wavecom GSM module is connected to 50-way connector K5, and the PC (if required) to the 9-way sub-D socket which is wired with the RxD and TxD lines only. At the modem side, the RS232 signals appear at TTL level (5 V swing), while symmetrical levels (max. ±15 V) are found at the PC side.

The two switching outputs are identical and consist of a buffer transistor type BC547 driving a power transistor type BD139. When the modem output PIO_x is active High, the BD139 conducts, allowing current to flow through the relay coil. Consequently, the relay contact will pull in, causing the mains voltage to be applied to the relevant load connected to K2 or K3. This is also indi-

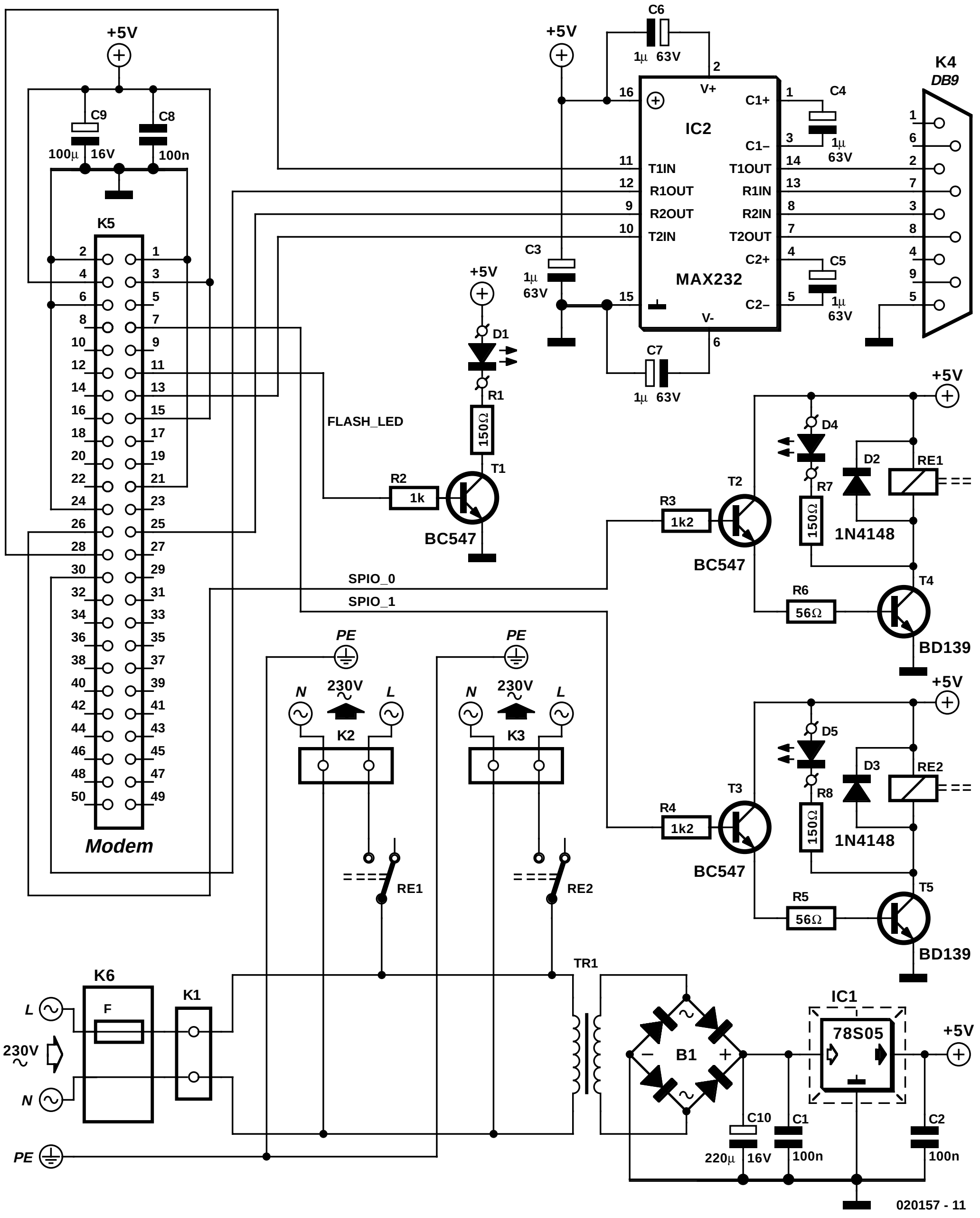


Figure 3. Sparse peripheral circuitry around the GSM modem.

cated by LED D4 or D5 lighting.

The power supply is standard throughout, consisting of a mains transformer, a rectifier, reservoir and smoothing capacitors and a fixed 5-V regulator. The mains transformer must be a **short-circuit resistant** type and the voltage regulator must be **adequately cooled**.

LED D1 is a flashing type. It will flash when the GSM modem receives the network transmitter, and lights constantly when communication takes place, for instance, during power-up and when the modem attempts to establish a network connection.

Construction

The PCB designed for the project is shown in **Figure 4**. It complies with relevant electrical safety regulations.

The contacts on connector K5 are spaced just 1.27 mm (0.05 inch) apart, so a soldering iron with a fine tip is required. If necessary, excess solder may be removed using desoldering braid. It is recommended to inspect the soldering job on K5 using a magnifying glass.

The rest of the construction should not cause problems as the soldering is much more 'spacious'. Be sure to mount polarized components the right way around, ad do not forget the five isolated wire links on the board — two of these are under the socket for IC2.

Next, the populated and functionally approved board is mounted in a suitable enclosure. The circuit **must** be built as a Class-1 device. No matter if an ABS or a metal case is used, the protective earth (PE) line must be connected through to the switched sockets as well as to all metal parts of the case.

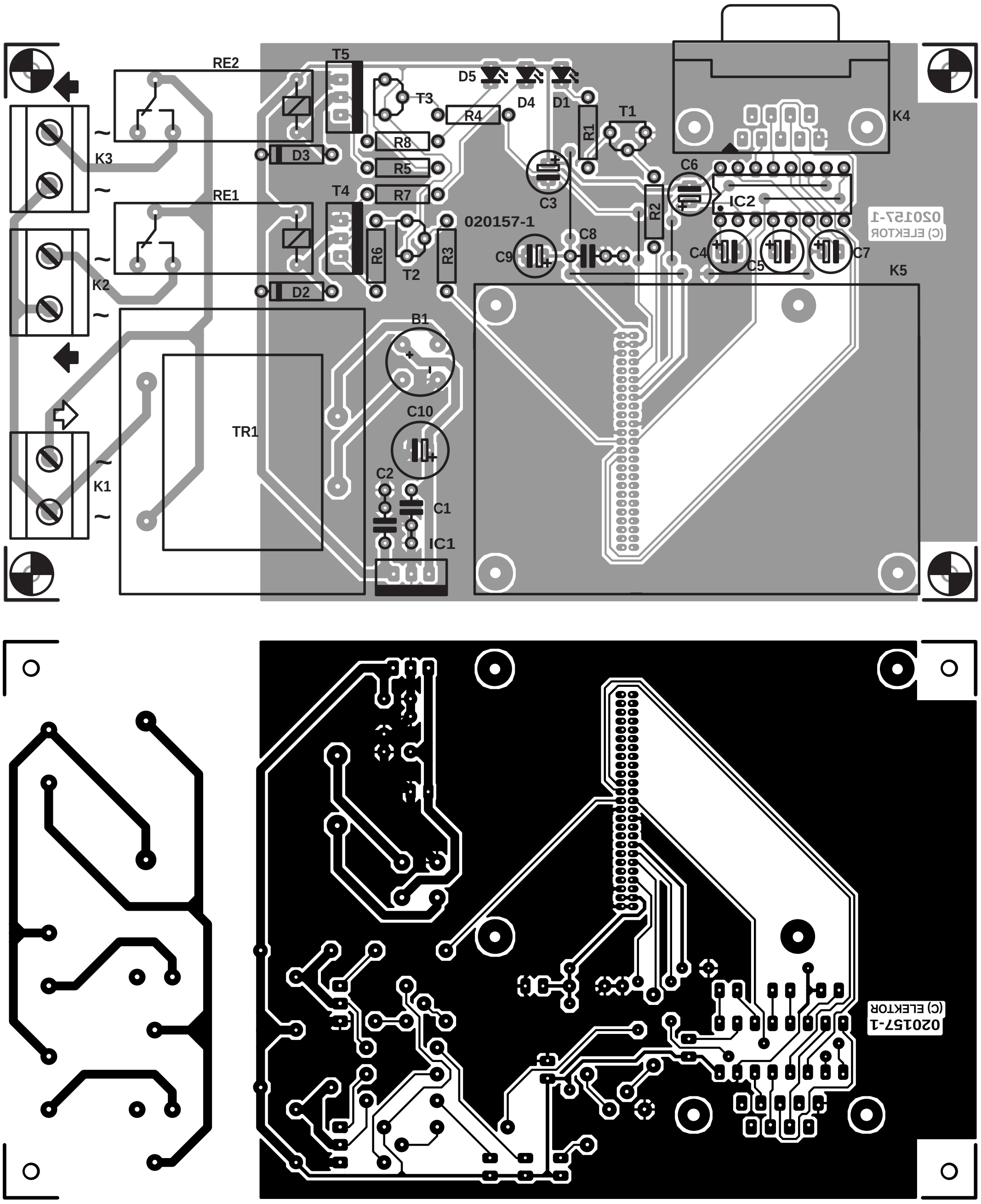


Figure 4. The PCB designed for the project.

Testing…

During all testing extreme care should be taken to prevent accidental contact with the potentially lethal voltages inside the unit.

Despite all visual checks, the expensive GSM modem should not be inserted into its socket when the circuit is first connected to the mains. The first test is limited to checking the presence of the 5-volt supply voltage. If this is available, unplug the unit from the mains and first prepare the GSM modem.

The modem of course requires a SIM card without a PIN on it (PIN = personal identification number). If a PIN is present, disable it using a GSM phone (if allowed by the GSM provider). Note the phone number that belongs with the SIM card, and write it down somewhere inside the case.

The SIM card inserted into the GSM module using the card tray next to the antenna input. Next, the modem is plugged into its socket. The modem is best secured using screws. Do not use washers or similar rings because of the risk of a short-circuit. Finally, plug on the antenna.

At power-on, some default values are applied:

```
PIN    0000
PIN Check    off
Reply  on
```

COMPONENTS LIST

Resistors:
R1,R7,R8 = 150Ω
R2 = 1kΩ
R3,R4 = 1kΩ2
R5,R6 = 56Ω

Capacitors:
C1,C2,C8 = 100nF
C3-C7 = 1µF 16V radial
C9 = 100µF 16V radial
C10 = 220µF 25V radial

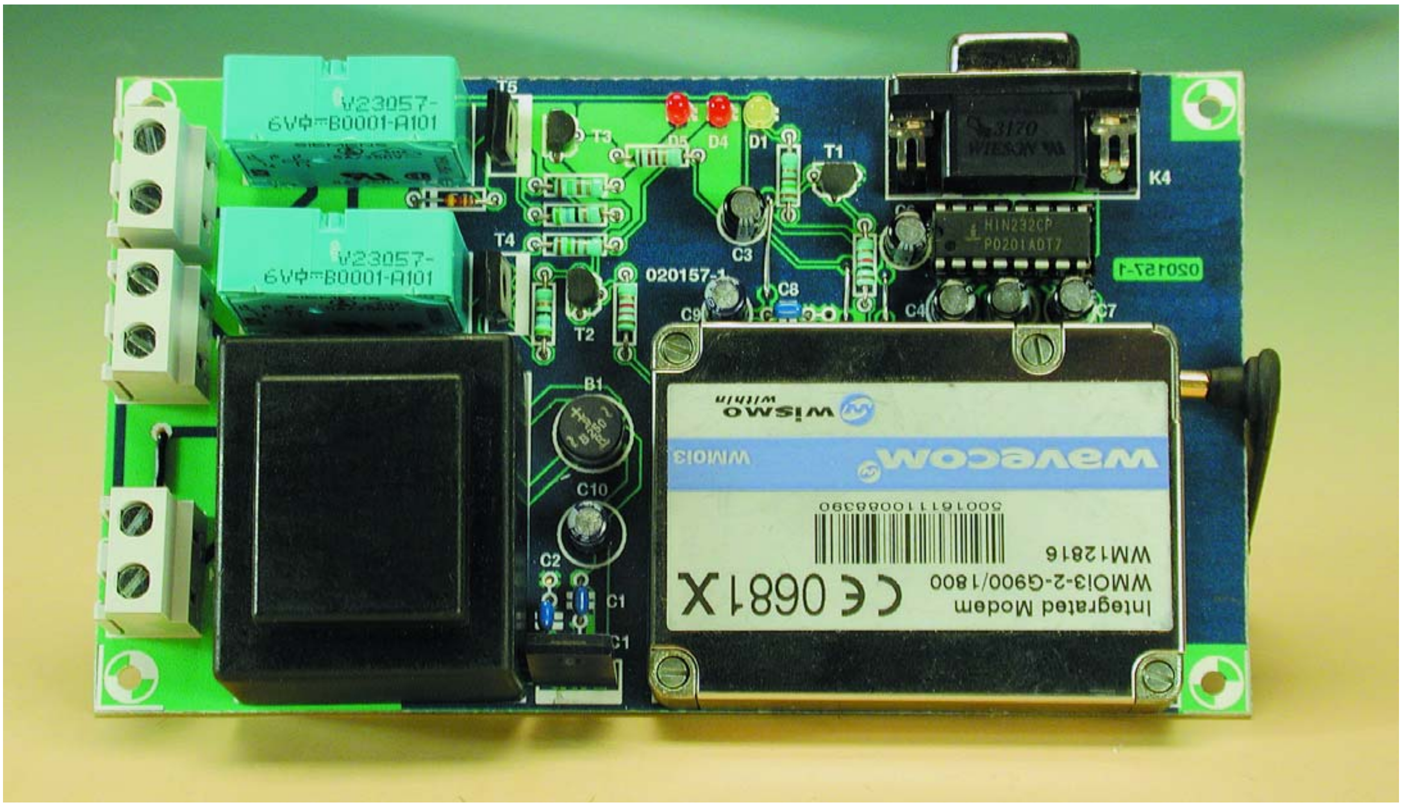
Semiconductors:
B1 = B80C1500 bridge rectifier in round case (80V piv, 1.5A peak)
D1 = LED, 3mm, yellow, low current
D2,D3 = 1N4148
D4,D5 = LED, 3mm, red, low current
IC1 = 78S05 (do not use 7805)
IC2 = MAX232
T1..T3 = BC 547B
T4,T5 = BD139

Miscellaneous:
Tr1 = mains transformer, 9 V / 3.6VA, short circuit resistant, e.g. Gerth # 387.09
Re1,Re2 = relay, 1 c/o contact, PCB mount, coil voltage 6V, contact rating 250V / 4A (Siemens V23057 B0001-A101)
K1,K2,K3 = 2-way PCB terminal block, lead pitch 7.5mm
K4 = 9-way sub-D socket, PCB mount, angled pins
K5 = 50-way PCB connector, straight, female, lead pitch 0.05” (Farnell # 672-348)
IEC mains appliance socket with fuse (15mA slow) and mains on/off switch
GSM Modem = WMOi3 (manufacturer: Wavecom; distributor: Unitronic)
GSM antenna with MMCX connector
2 mains sockets, panel mount, to BS1363
PCB, order code **020157-1**

Suggested suppliers:

GSM modem
Unitronic AG, Mündelheimer Weg 9,
D-40472 Düsseldorf, Germany.
Tel. (+49) 211 9511-0,
fax. (+49) 211 9511-111.
mail : info@unitronic.de.
Website : www.unitronic.de

GSM antenna
IMS Connectors Systems GmbH,
Obere Hauptstrasse 30, D-79840
Löfflingen, Germany.
Tel. (+49) 76 5490 10,
fax (+49) 76 5490 1199.
Email: sales@imscs.com.
Website: www.imscs.com



These values may be changed by SMS, in fact this should be done right away to eliminate the risk of anyone being able to switch the sockets on and off! The first SMS to the modem should be used to set a PIN. The command to do so looks like this:

```
change password;<old PIN>;<new PIN>
```

For example, if your new PIN is 0815 send this message:

```
change password;0000;0815
```

The GSM modem will change the PIN and return a confirmation message 'password changed'. From them on, the mains sockets can only be switched on and off if the relevant command contains the correct PIN.

Let's try this out straight away by switching on a socket. Her is the general format:

```
#<password>;socket number>,<on/off>,<date>,<time>
```

This may look a bit complex but don't be put off because not all fields have to be filled. If you send this message

```
#0815;1,1,,
```

then the load on socket #1 is switched on instantly. The commas should not be omitted! **Table 1** shows an overview of all available commands.

The RS232 interface should also be tested. The format used is 8,N,1,9600. The OpenAT program is automatically active at power-on. The modem then only responds to the following commands received via RS232:

AT+RESET
Returns the modem to its default values. A very useful command if you have forgotten the system PIN.

AT+WOPEN+2
Halts the program and returns the modem to normal operation. From then on, the modem may be controlled using AT commands, This mode allows the modem to be installed under Windows and then establish a connection with the Internet. Such a connection is however only possible if the modem was re-programmed with the new GPRS firmware (and if the SIM card you're using is GPRS compatible). The relevant firmware may be obtained from Unitronic.

AT+WDWL
This allows a new program to be loaded into the modem. Program loading employs the X Modem protocol which is supported by most communication and terminal emulation programs (including HyperTerminal).

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SMS Commands

SWITCHING OUTPUT

Format: ***#<password>;<socket number>,<on/off>,<date>,<time>***

This command controls one or more outputs via SMS. Not all fields require data, and some are optional.

Password	When PIN checking is active, the PIN should be entered here.
Socket number	1 = Output #1, 2= Output #2, 0 = both outputs
On/off	1= on, 0 = off
Date	yy/mm/dd (e.g., 03/09/15 means 15 September 2003). When the field is empty, the current date is used.
Time	hh:mm (e.g., 13.30h). When the field is empty, the current time is used.

It is possible to include multiple switching commends in one SMS message. The second command is simply written after the first one. Subsequent commands do not require the string ***#<password>;***
Up to 16 switching functions may be programmed.

Response: ***<command> : accepted***

Examples

#7324;1,1,,	Switch on load #1 immediately
#7324;2,1,03/09/15,12:00	Switch on load #2 on 15 September 2003 at 12:00h
#7324;1,0,03/09/15,13:00,2,0,03/09/15,13:01	Switch on load #1 on 15 September 2003 at 13:00h, switch off load # 2 on 15 September 2003 at 13:01h

GET SWITCHES

Format: ***switch?***

This command retrieves the commands issued to both outputs. The GSM modem replies by sending an SMS containing all received and accepted actions.

Example

Command `switch?`

Response

```
1,1,,;0
2,1,03/09/15,21:00;1
1,0,03/09/15,13:00;2
2,0,03/09/15,13:01;3
```

The last digit in each line is an index number. The index is required if the user wants to clear a certain action.

DELETE SWITCH

Format: `delete switch;<password>;<index>`

This command causes the following action:

Password	When PIN checking is active, the PIN should be entered here.
Index	Index number of the action to be cleared is issued in GET SWITCHES.

Example

Command `delete switch;7324;1`

Response `Switch 1 : deleted`

It is also possible to clear all actions in one go by using Index number 16:

Command `delete switch;7324;16`

Response `Switch 16 : deleted`

SET REAL TIME CLOCK

This command allows the time and date to be adjusted.

Format: `rtc;<password>;<date>,<time>`

Date	yy/mm/dd (e.g., 03/09/15 means 15 September 2003)
Time	hh:mm (e.g., 13:30h)

Example

Command `rtc;7324;03/09/07,10:49`

Response `The rtc is set successfully`

GET REAL TIME CLOCK

Queries the time and date set in the modem.

Format: `rtc?`

Example

Command `rtc?`

Response `03/09/07,11:01`

CHANGE PASSWORD

Allows you to change the password.

Format:	`change password;<old password>,<new password>`

`old password`	old PIN
`new password`	new PIN

Example

Command	`change password;7324,0123`
Response	`Password changed`

DISABLE/ENABLE PASSWORD

Switch PIN checking on and off.

Format:	`password;<password>;<enable/disable>`

`password`	PIN
`enable/disable`	0 = disable checking; 1 = enable checking

Example

Command	`password;0123;0`
Response	`Password disabled`

DISABLE/ENABLE RESPONSE

If desired the GSM modem can acknowledge any command entry.

Format:	`response;<password>;<enable/disable>`

`password`	PIN
`enable/disable`	0 = switch off acknowledge; 1 = switch on acknowledge

Examples

Command	`response;0123;0`
Response	none (acknowledge switched off)

Command	`response;0123;1`
Response	`Response enabled`

GET REPORT

This command prompts the modem to supply a status report.

Format:	`report?`

This command is always performed, even if Acknowledge is switched off.

Example

Command	`report?`

Response

```
Socket 1   : on
Socket 2   : off
Password   : enabled
Response   : enabled
Time : 11:05
Date : 03/07/29
```